

Modelflow estimates of stroke volume do not correlate with Doppler ultrasound estimates during upright posture.

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Orthostatic intolerance affects 60-80% of astronauts returning from long-duration missions, representing a significant risk to completing mission-critical tasks. While likely multifactorial, a reduction in stroke volume (SV) represents one factor contributing to orthostatic intolerance during stand and head up tilt (HUT) tests. Current measures of SV during stand or HUT tests use Doppler ultrasound and require a trained operator and specialized equipment, restricting its use in the field. BeatScope (Finapres Medical Systems BV, The Netherlands) uses a modelflow algorithm to estimate SV from continuous blood pressure waveforms in supine subjects; however, evidence supporting the use of Modelflow to estimate SV in subjects completing stand or HUT tests remain scarce. Furthermore, because the blood pressure device is held extended at heart level during HUT tests, but allowed to rest at the side during stand tests, changes in the finger arterial pressure waveform resulting from arm positioning could alter modelflow estimated SV. The purpose of this project was to compare Doppler ultrasound and BeatScope estimations of SV to determine if BeatScope can be used during stand or HUT tests. Finger photoplethysmography was used to acquire arterial pressure waveforms corrected for hydrostatic finger-to-heart height using the Finometer (FM) and Portapres (PP) arterial pressure devices in 10 subjects (5 men and 5 women) during a stand test while simultaneous estimates of SV were collected using Doppler ultrasound. Measures were made after 5 minutes of supine rest and while subjects stood for 5 minutes. Next, SV estimates were reacquired while each arm was independently raised to heart level, a position similar to tilt testing. Supine SV estimates were not significantly different between all three devices (FM: 68±20, PP: 71±21, US: 73±21 ml/beat). Upon standing, the change in SV estimated by FM (-18±8 ml) was not different from PP (-21±12), but both were significantly less than US (-37±16 ml, $p<.05$). Raising finger BP devices to heart level caused no significant change in SV measured with any of the devices (FM: 1.5±19, PP: 1.7±26, US: 0.5±6), although variability was 3-6x greater as assessed by both blood pressure devices compared to US. Retrospective analysis of blood pressure data to assess SV in 11 supine subjects revealed significantly different estimates between methods (FM: 95±17, US: 75±32, $p<.05$), but the change in SV resulting from HUT was similar between methods (FM: -37±9, US: -40±18 ml). However, the correlation coefficient determined from pairs of SV estimated by US and FM was weak ($r^2=0.03$). These data suggest Modelflow cannot be used in lieu of Doppler ultrasound to estimate SV during stand or HUT tests. Further investigation should focus on identifying factors contributing to differences between these measurement techniques in order to make use of a simple method for assessing beat-by-beat changes in SV during postural changes, especially during field testing.

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